## Noteworthy anatomical and physiological researches.

### The littoral flora of Belgium.[1]

The flora of the Belgian littoral presents so many points of interest in common with those which may be found along our own seaboards and the great lakes, that it has seemed fitting to give a somewhat extended abstract of this paper. As the original title suggests, it is not a mere list of plants growing upon the coast of Belgium. On the other hand the subject is treated entirely from a biological standpoint and is well deserving of the attention of American botanists, many of whom have unsurpassed advantages for undertaking similar lines of study.

The most important topics, are indicated by corresponding subheads in this résumé.

1. *Physical conditions.* The shore of Belgium consists of a continuous range of dunes of moving sand, varying in width from $3^{km}$ to a line so narrow that it is reinforced with dikes. Between these dunes are more or less deep and extended valleys.

The calcium carbonate and other salts which are dashed over these hillocks by the waves filter quickly through the light sand. The wind is continually changing the contour of the dunes, which are remarkable for their dryness. The valleys separating them, on the contrary, are kept more or less moist owing to an impermeable stratum of clay which underlies them. The largest valleys are called "pannes" and are frequently cultivated. Their flora resembles that of the marshes of the interior, and is devoid of any peculiarly littoral character.

Where the Yser empties into the sea the tide backs up carrying with it the particles of earth held in suspension by the river water. These are deposited along the estuary forming sheets of clay called "schorres."

Owing to the action of the waves a constant subsidence of the hills takes place, although this is sometimes counter-balanced by new dunes formed by the sand deposited by the ocean currents.

[1] La biologie de la vegetation sur le littoral Belge. Jean Massart. Bull, de la Soc. roy. de Botanique de Belgique. **32**: 7–43. *4*. 1893.

The dunes and the schorres possess each a distinct type of vegetation. The plants of the former, owing to the extreme dryness which prevails, obtain water with great difficulty and furnish a series of structures adapted to secure proper absorption and storage of the water taken from the soil, and a reduction of the loss of water by evaporation. The wind, too, offers a very serious obstacle to the dune plants in their development. It lays bare their roots, enfilades the plants with sand, or buries them deeply in the drifts.

Owing to unlike conditions of existence the schorre vegetation is quite different. The earth is so compact that rain does not penetrate it; moreover, twice each day it is entirely inundated by the sea. Instead of resembling the flora of the marshes, the schorre plants, like those of the dunes, are adapted to drouth. This is due to their xerophilous character. As is well known, vegetation becomes xerophilous not only in localities where water is rare, but also in places where, although sufficiently abundant, it occurs in such a state as to be absorbed with difficulty. Thus the frequent and apparently astonishing xerophilous character of arctic and alpine plants which push into the water, is due to a large extent to the reduction of the amount of water which they can take from the soil, resulting from the simple cooling of the earth.

In the case of vegetation in contact with the sea or an equally strong solution of salt, the plant absorbs water with difficulty since the liquid of the cells is much less concentrated than that of the external solution. Hence such plants need to economize their water so as not to be compelled to renew it frequently.

2. *Means of protection against drouth.* The winters on the Belgian coast are humid and comparatively mild, while extreme drouth prevails during the summer. Hence many of the dune plants are exclusively hibernal in their growth, and, dried and shriveled, pass the summer in a dormant state.

The schorres, on the contrary, are almost completely deprived of vegetation during the winter; the only plants which remain green are those with very short leaves (Glyceria, Armeria, etc.). This fact is probably due to the periodical submergence which the schorres undergo; the partly frozen water brought in by the tide tears up the soil and pulls out everything above its surface.

The faculty which dune plants possess of developing in winter and early spring has doubtless been acquired in order that they may escape the unfavorable conditions to which they would be subject in summer.

Various contrivances are possessed by the dune plants for securing the absorption of water and preventing its evaporation. Chief among the former is the very extensive root system with which nearly all of them are provided. Eryngium maritimum, for example, often has roots more than $3^m$ long.

A good number have their leaves so arranged as to protect the soil against evaporation; they are applied closely to the sand, as in Erodium and most of the Compositæ (Thrincia, Leontodon, Senecio Jacobaea, etc.). Upon pulling the plant up by the roots it is seen that the leaves bend back towards the base; the petiole forms a spring, probably due to a difference in turgescence between the upper and lower face, and presses the blade energetically against the soil. This prevents the wind from disturbing the superficial layers of sand, and thus checks evaporation.

Other species, very numerous, form a screen; the wind breaks against them before striking the earth. Some of these are shrubs, as Hippophaë, Ligustrum, Salix repens, etc.; others are low, cushion-like herbs, such as Galium Mollugo and G. verum, Ononis repens, Anthyllis Vulneraria, etc.

Contrivances for storing up water are common, advantage being taken of the intermittent rains to make provision for water against periods of drouth.

Fleshy plants, however, are rare in the dunes; only Sedum acre, Euphorbia Paralias, Lotus corniculatus var. crassifolius, Convolvulus, Soldanella, etc. are found. This dearth of fleshy plants is attributed to the destructive action exercised upon them by the wind charged with grains of sand; it is rare to find an adult leaf of a fleshy plant, of Lotus, for example, which is not injured in many places.

Wherever the land is subject to tides, as on the schorres and at the base of the dunes close to the sea, plants with fleshy leaves or stems predominate. Among such plants are Cakile, Salsola, Honckenya, Salicornia, Suaeda, Statice, Armeria, Glaux, Spergularia, etc.

The author attributes the stunted condition of the littoral plants to the fact that they seek in every way to limit the loss of water; transpiration is thus reduced and the amount of

food correspondingly lessened. From the law that transpiration is more rapid on a convex than on a plane surface the author explains the fact that the epidermal cells of Glyceria, Agropyrum, and Lotus corniculatus growing in saline soils are almost flat while the same plants in aquatic situations have strongly convex epidermal cells.

The dune plants have an abundant clothing of hairs, which being feeble conductors of heat, considerably reduce transpiration. Many of the xerophilous plants have a very pronounced odor, e. g., the stems of Thymus Serpyllum belong almost exclusively to the variety citriodorus, which is much richer in volatile substances than the type. The evaporation of this volatile matter creates around the plant an atmosphere through which heat rays pass with difficulty.

Transpiration is also lessened in many of the grasses by the well-known phenomenon of the conduplication and inrolling of the leaves. In such grasses the stomata are almost always upon the upper side of the leaf. In others evaporation is hindered by the possession of thick cuticles, strongly impregnated with suberin, and in the case of Agropyrum and other grasses by the thickening of the walls of the cells composing the fibro-vascular sheath. The increased transpiration which results from shocks is hindered in the dune plants by their remarkable rigidity, which is due both to the rolling up of the leaves and the extraordinary development of sclerenchymatous tissue. The plants of the schorres owe their rigidity to their fleshy nature.

Injury from excessive light is prevented in some cases by the hairs situated upon the upper surface of the leaves, shading the green cells, thus hindering chlorovaporisation. In the genus Halimus the edges of the leaves turn towards the sun to secure the same object.

3. *Protection against the wind and animals.* The high winds exercise a very destructive influence upon the littoral flora, not only by breaking stems, tearing leaves and denuding the roots, but also by their great drying action. To obviate this the majority of the arenicolous plants are tough and elastic; others have strong hold-fast roots or a compact and prostrate habit; still others produce numerous stolons.

Protection against animals of the littoral, of which the rabbit is chief, is afforded to some plants by their hard character and impregnation with silica; some (Hippophaë, Eryngium)

are armed with spines; others (Ononis) are covered with sand; still others have a bitter taste (Salix, Galium verum), or are acrid (Euphorbia Paralias); many contain essential oils displeasing to herbivora, finally, the fleshy plants, the most exposed of all, are strongly protected by their saline flavor (Cakile, Salsola, Salicornia, Aster, Statice).

4. *Origin of the littoral flora.* The paucity of species of the littoral flora is accounted for by the diversity of destructive causes at work, which also explains the great number of individuals in the case of those plants which are well adapted to the prevalent conditions.

In order to throw light upon this subject the author has sown and transplanted to Brussels a large number of the plants of the dunes and schorres. This will be followed by a study of whatever modifications take place because of this change of environment. The inverse experiment has also been tried of transplanting 400 species of perennials cultivated in the Botanic Garden at Brussels, to various places along the coast —GILBERT H. HICKS.

### Nature and life history of starch grains.[1]

The recently published work of Meyer forms the most important contribution to the knowledge of starch grains which has appeared since Schimper's researches in 1880. According to Meyer, starch grains are true sphere crystals in every way analogous to the sphere crystals of inulin, and are composed of two forms of amylose and a trace of amylodextrin. In an anomalous form which colors reddish-brown with iodine, the proportion of amylodextrin is very large. This red starch is characteristic of a large number of saprophytes but has been found in less than a score of the higher green plants. In opposition to the theory of Tammann, Meyer finds that the action of diastase on starch is a purely katalytic process and in every way analagous to the katalytic action of acids except that it is more easily influenced by external conditions, such as heat, etc.

Under diastatic action, amylose takes up water and splits into two molecules of amylodextrin, which is transformed into isomaltose and dextrin. Both of these substances pass

[1] Arthur Meyer. Untersuchungen über die Stärkekörner. Wesen und Lebensgeschichte der Stärkekörner der höheren Pflanzen. pp. xvi+318. pl. 9, figs. 99. Gustav Fischer. Jena. 1895.